

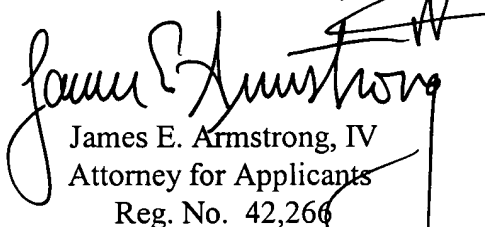
REMARKS

The above amendment is submitted to place the specification and claims in substantially the same condition as the specification and claims as amended under Article 34 in the international application. An English translation of the annexes of the PCT international preliminary examination report is enclosed. Early and favorable action is awaited.

In the event that any fees are due in connection with this paper, please charge our Deposit Account No. 01-2340.

Respectfully submitted,

ARMSTRONG, KRATZ, QUINTOS,
HANSON & BROOKS, LLP


James E. Armstrong, IV
Attorney for Applicants
Reg. No. 42,266

JAM/jaz
Atty. Docket No. **060546**
Suite 1000
1725 K Street, N.W.
Washington, D.C. 20006
(202) 659-2930



23850

PATENT TRADEMARK OFFICE

DESCRIPTION

DRYING APPARATUS AND OPERATING METHOD THEREOF

Technical Field

The present invention relates to a drying apparatus used for drying clothing or bathroom, or for a vending machine, and to an operating method of the drying apparatus.

Background Technique

As a conventional heat pump apparatus, there is a heat pump type drying apparatus in which a heat pump is used as a heat source and drying air is circulated (see patent document 1 for example). Fig. 10 shows a structure of the conventional heat pump type drying apparatus described in the patent document 1.

In the clothing dryer shown in Fig. 10, a rotation drum 2 is used as a drying room which is provided in a body 1 of the clothing dryer so as to rotate freely. The rotation drum 2 is driven by a motor 3 through a drum belt 4. A blower 22 is driven by the motor 3 through a fan belt 8. The blower 22 sends drying air from the rotation drum 2 to a circulation duct 18 through a filter 11 and a rotation drum-side air intake 10.

The heat pump apparatus comprises an evaporator 23 which evaporates a refrigerant to dehumidify drying air, a condenser 24 for condensing the refrigerant to heat the drying air, a compressor 25 for generating a pressure difference in the refrigerant, an expansion mechanism 26 such as a capillary tube for maintaining the pressure difference of the refrigerant, and a pipe 27 through which the refrigerant passes. A portion of the drying air heated by the condenser 24 is discharged outside from the body 1 through an exhaust port 28.

Next, the operation of the drying apparatus will be explained. First, clothing 21 to be dried is placed in the rotation drum 2. Then, if the motor 3 is rotated, the rotation drum 2 and the blower 22 rotate and drying air flow B is generated.

CO₂ refrigerant is used, theoretic efficient of the heat pump system is low as compared with the HFC refrigerant, and the operating efficiency of the heat pump type drying apparatus is deteriorated. Thus, there is a problem that energy must be saved and the efficiency must be enhanced to reduce the indirect affect on the global warming by using a natural refrigerant such as CO₂ which does not directly affect the global warming.

The present invention has been accomplished in view of the conventional problems, and it is an object of the invention to provide a drying apparatus which enhances its efficiency while avoiding the excessive rise of the discharge pressure of the compressor also under a high outside temperature condition when a refrigerant that is brought into a supercritical state on the radiation side of a heat pump cycle such as CO₂ is used as a refrigerant.

Disclosure of the Invention

A first aspect of the present invention provides a drying apparatus comprising a heat pump apparatus in which a refrigerant is circulated through a compressor, a radiator, a first throttle apparatus, a heat exchanger, a second throttle apparatus and an evaporator in this order, a circulation duct through which drying air is circulated and in which the radiator, the heat exchanger and the evaporator are disposed in this order from upstream side of flow of the drying air, and a drying room connected to the circulation duct.

With this aspect, switching operation between the first throttle apparatus and the second throttle apparatus is carried out and thus, the heat exchanger can be utilized as the second radiator or the second evaporator. Therefore, this aspect provides the operating method of the heat pump apparatus in which the discharge pressure and the suction pressure of the compressor when the outside air temperature is high do not rise excessively the refrigeration cycle is stabilized. That is, the refrigeration cycle is stabilized and its efficiency can

be enhanced.

A second aspect of the present invention provides an operating method of a heat pump apparatus in the drying apparatus of the first aspect, the heat exchanger is used as a second evaporator or a second radiator by operating the first throttle apparatus and the throttle apparatus.

With this aspect, the heat exchanger is utilized as the second radiator in the drying process, the total heat release to the drying air can be increased, an amount of heat transferred to water remaining in the clothing can be secured, it is possible to prevent the drying time from increasing, and the consumption electricity required for the drying operation can be reduced.

According to a third aspect of the invention, in the drying apparatus of the first aspect, the drying apparatus further comprises discharge pressure detecting means for detecting discharge pressure of the compressor, and throttle apparatus control means for controlling the first throttle apparatus and the second throttle apparatus using a detection value from the discharge pressure detecting means.

With this aspect, the heat exchanger can be utilized as the radiator in accordance with the discharge pressure of the compressor, it is possible to prevent the discharge pressure from excessively rising, the reliability of the compressor and the like can reliably be secured, and the refrigeration cycle can be operated stably and efficiently.

According to a fourth aspect of the invention, in the drying apparatus of the first aspect, the drying apparatus further comprises discharge temperature detecting means for detecting discharge temperature of the compressor, and throttle apparatus control means for controlling the first throttle apparatus and the second throttle apparatus using a detection value from the discharge temperature detecting means.

With this aspect, the heat exchanger can be utilized as the radiator in accordance with the discharge temperature of the compressor, it is possible to prevent the discharge pressure from excessively rising, the reliability of the compressor and the like can reliably be secured, and the refrigeration cycle

can be operated stably and efficiently.

According to a fifth aspect of the invention, in the drying apparatus of the first aspect, the drying apparatus further comprises air temperature detecting means for detecting inlet air temperature of the evaporator, and throttle apparatus control means for controlling the first throttle apparatus and the second throttle apparatus using a detection value from the air temperature detecting means.

With this aspect, the heat exchanger can be utilized as the radiator in accordance with the inlet air temperature of the evaporator, the heat release can be increased when the drying operation is completed, and it is possible to prevent the drying time from increasing.

According to a sixth aspect of the invention, in the drying apparatus of the first aspect, a high pressure side of the heat pump apparatus is operated as a supercritical state.

With this aspect, heat exchanging efficiency between the refrigerant and the drying air in the radiator can be enhanced, the drying air can be heated to higher temperature and the drying operation can be carried out within a short time.

According to a seventh aspect of the invention, in the drying apparatus of the first aspect, carbon dioxide is used as the refrigerant.

With this aspect, the drying air can be heated to higher temperature, the drying operation can be carried out within a short time, and influence of the global warming can be reduced.

Brief Description of the Drawings

Fig. 1 shows a structure of a heat pump apparatus of a first embodiment of the present invention;

Fig. 2 shows a relation between a channel resistance of a first throttle apparatus and an outlet refrigerant temperature of the first throttle apparatus of the first embodiment of the invention;

Fig. 3 shows a structure of a heat pump apparatus of a second embodiment of the invention;

36 is detected, and the channel resistances of the first throttle apparatus 33 and the second throttle apparatus 35 are controlled based on the detected inlet air temperature. Thus, although an amount of heat transferred to water remaining in the clothing is reduced when the drying operation is completed in the conventional example, since the heat exchanger 34 is utilized as the radiator in the present invention, the heat release can be increased as compared with the conventional example, and it is possible to prevent the drying time from increasing, and the consumption of electricity required for the drying operation can be reduced.

The present invention has effect not only when the invention is used for drying clothing, but also when the invention is used for drying a bathroom, tableware and the like and the invention has effect when the invention is applied to a heat pump apparatus such as a vending machine.

According to the heat pump apparatus of the invention, since the heat exchanger can be utilized as a radiator and as an evaporator, the discharge pressure or suction pressure of the compressor does not excessively rise when the outside air temperature is high. Thus, the refrigeration cycle is stabilized, and the efficiency of the refrigeration cycle is enhanced, and the consumption of electricity required for the drying operation can be reduced.

When the heat pump apparatus is used for drying operation, since the use of the heat exchanger can be switched from the evaporator to the radiator, it is possible to always secure the amount of heat transferred to water remaining in clothing, and to prevent the drying time from increasing, and the consumption of electricity required for the drying operation can be reduced.

Industrial Applicability

The drying apparatus of the present invention can suitably be used for drying clothing, bathroom and the like. Further, the heat pump apparatus can also be used for other

CLAIMS

1. (amended) A drying apparatus comprising
a heat pump apparatus in which a refrigerant is circulated
through a compressor, a radiator, a first throttle apparatus,
a heat exchanger, a second throttle apparatus and an evaporator
in this order,
a circulation duct through which drying air is circulated
and in which said radiator, said heat exchanger and said
evaporator are disposed in this order from upstream side of
flow of the drying air, and
a drying room connected to said circulation duct.
2. (amended) An operating method of a heat pump apparatus
in the drying apparatus according to claim 1, wherein said heat
exchanger is used as a second evaporator or a second radiator
by operating said first throttle apparatus and said throttle
apparatus.
3. (amended) The drying apparatus according to claim 1,
further comprising discharge pressure detecting means for
detecting discharge pressure of the compressor, and throttle
apparatus control means for controlling said first throttle
apparatus and said second throttle apparatus using a detection
value from said discharge pressure detecting means.
4. (amended) The drying apparatus according to claim 1,
further comprising discharge temperature detecting means for
detecting discharge temperature of the compressor, and throttle
apparatus control means for controlling said first throttle
apparatus and said second throttle apparatus using a detection
value from said discharge temperature detecting means.
5. (amended) The drying apparatus according to claim 1,
further comprising air temperature detecting means for
detecting inlet air temperature of said evaporator, and throttle

apparatus control means for controlling said first throttle apparatus and said second throttle apparatus using a detection value from said air temperature detecting means.

6. (amended) The drying apparatus

according to claim 1, wherein a high pressure side of said heat pump apparatus is operated as a supercritical state.

7. (amended) The drying apparatus according to claim 1, wherein carbon dioxide is used as the refrigerant.